

CLAIMS

1. A method of forming a member having an inside-diameter portion with a small diameter, comprising the steps of forming a large-diameter recess in a material; machining the recess; and swaging the material from an outside by inserting a mandrel having a diameter equal to a diameter of an inner peripheral portion of an aimed member.

2. A method of forming a member, including a method of providing an undercut in an inner peripheral portion of the member, comprising the steps of:

1: forming a recess having a diameter larger than that of the inner peripheral portion of the member in a material;

2: forming an undercut at an inner periphery of the recess;

3: inserting a mandrel having a diameter equal to a diameter of an inner peripheral portion of an aimed member into the recess of the material having been formed with the undercut; and

4: swaging, from an outside, the material into which the mandrel has been inserted so that an inside diameter of the recess of the material is decreased to an outside diameter of the mandrel with the undercut left.

3. The method of forming a member according to claim 2, characterized in that the member is a fuel injection nozzle.

4. A method of forming a member having an undercut, comprising the steps of forming a recess having a diameter larger than the diameter of an inner peripheral portion of the member in a material; forming the undercut at an inner periphery of the recess; inserting a mandrel having a diameter equal to a diameter of an inner peripheral portion of an aimed member and having a conical tip end portion into the

recess of the material having been formed with the undercut; and swaging, from an outside, the material into which the mandrel has been inserted, by which an inside diameter of the recess of the material is decreased to an outside diameter of the mandrel with the undercut left, and at the same time, a tip end portion of the inner peripheral portion of the aimed member is formed into a female taper shape following the tip end portion of the mandrel.

5. The method of forming a member having an undercut according to claim 4, characterized in that a positioning hole into which the mandrel tip end portion is inserted is formed in a center of the large-diameter recess, and a depth of the positioning hole is equal to or shallower than a length of the mandrel tip end portion and an opening angle thereof is equal to or larger than an angle of the mandrel tip end portion.

6. The method of forming a member having an undercut according to claim 5, characterized in that the positioning hole is formed by forging at the same time that the recess is formed.

7. The method of forming a member having an undercut according to claims 4 to 6, characterized in that the member is a fuel injection nozzle.

8. A method of forming a member having an undercut, comprising the steps of forming a recess having a diameter larger than the diameter of an inner peripheral portion of the member in a material; forming the undercut at an inner periphery of the recess; inserting a mandrel having a diameter equal to a diameter of an inner peripheral portion of an aimed member into the recess of the material having been formed with the undercut; and swaging, from an outside, the material into which the

mandrel has been inserted so that an inside diameter of the recess of the material is decreased to an outside diameter of the mandrel with the undercut left, characterized in that a chamfered portion is formed in a bottom portion of the recess of the material before the swaging operation, and a formation region of the chamfered portion is within an outside region that provides a clearance with a tip end of the mandrel abutted on the bottom portion of the recess.

9. The method of forming a member having an undercut according to claim 8, characterized in that the formation region of the chamfered portion is 35 to 100% of a clearance between the mandrel and the inner periphery of the recess.

10. The method of forming a member having an undercut according to claim 8 or 9, characterized in that the member is a fuel injection nozzle.

11. A method of forming a member having an undercut, comprising the steps of forming a recess having a diameter larger than the diameter of an inner peripheral portion of the member in a material; forming the undercut at an inner periphery of the recess; inserting a mandrel having a diameter equal to a diameter of an inner peripheral portion of an aimed member into the recess of the material having been formed with the undercut; and swaging, from an outside, the material into which the mandrel has been inserted so that an inside diameter of the recess of the material is decreased to an outside diameter of the mandrel with the undercut left, characterized in that an excess thickness portion is provided in a predetermined length range from a bottom of the recess at the inner or an outer periphery of the recess of the material before the swaging operation.

12. The method of forming a member having an undercut according to claim 11, characterized in that the excess thickness portion is formed by forging at the same time that the recess is formed.

13. The method of forming a member having an undercut according to claim 11 or 12, characterized in that the member is a fuel injection nozzle.

14. A valve guide for slidably guiding a valve stem, characterized in that the valve guide is formed of an Al-base composite material, and an oil groove is formed in an inner peripheral surface of the valve guide.

15. A method of forming a valve guide for slidably guiding a valve stem, comprising the steps of forming a recess having a diameter larger than the diameter of an inner peripheral portion into which the valve stem is inserted in a valve material; and swaging, from an outside, the material into which a mandrel has been inserted so that an inside diameter of the recess of the material is decreased to an outside diameter of the mandrel by inserting the mandrel having almost a same diameter as the diameter of the valve stem into the large-diameter recess.

16. The method of forming a valve guide according to claim 15, characterized in that a groove remaining as an oil groove after swaging operation is formed in advance in an inner peripheral surface of the large-diameter recess.

17. The method of forming a valve guide according to claim 15, characterized in that the material is an Al-base composite material.

18. A method of forming a tubular member formed with a small-diameter hole along the axial direction, comprising the steps of obtaining an intermediate material such that a diameter of an inside-diameter hole has a dimension allowing metal plating; forming a metallic deposit in the inside-diameter hole of the intermediate material; and swaging, from an outside diameter side, the intermediate material into which a mandrel has been inserted so that the diameter of the inside-diameter hole of the intermediate material is decreased to an outside diameter of the mandrel by inserting the mandrel having a diameter corresponding to the diameter of the small-diameter hole of an aimed tubular member into the inside-diameter hole of the intermediate material formed with the metallic deposit.

19. The method of forming a tubular member according to claim 18, characterized in that a material for the tubular member is an aluminum alloy or an aluminum-base composite material, and a material for the metallic deposit a highly wear resistant material such as iron (Fe) or nickel – silicon carbide (Ni-SiC).